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THE DEPENDENCE BETWEEN THE HALF PERIOD OF K-CAPTURE AND THE ENERGY OF GAMMA RADIATION

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In the development of nuclear physics, a great role has been played by empirically found relations between alpha or beta decay and the energy of the particle ejected. Similar relations for processes of K-capture cannot at present be established, since, on the one hand, the energy of the emitted neutrino is not amenable to measurements and, on the other, the masses of the original and final nuclei are not measured with sufficient accuracy.

The energy of the gamma quantum emitted by the nucleus product is the only quantity connected with the energy released during K-capture, which energy is measured in many cases with sufficient accuracy.

This article reveals the results of an attempt to establish a connection between this quantity and the decay constant for K-active nuclei.

If the logarithm of the half period of K-capture is taken as the y-axis, and the energy of the gamma quantum, in Mev's, radiated by the nucleus product is given along the x-axis, then most nuclei for which K-capture is observed will lie along four straight lines I, II, III, IV, only four nuclei lie on line V, and approximately 15 nuclei form two groups A and B lying on both sides of the other five lines; all seven lines lie roughly parallel and their extensions would intersect both positive x and y axes. Possibly these groups A and B also are segments of certain straight lines.

/The original article contained a graph of these four straight lines, which is not reproduced here./

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In the construction of the graph, only those nuclei were taken whose K-capture is not accompanied by the instantaneous emission of light (electrons or positron) or heavy (alpha particles) particles. If the nucleus emits, after K-capture, two or more gamma quanta in succession, for example $^{181}_{74}W$ and $^{169}_{70}Y$, then the total energy of all these gamma quanta is taken. If the nucleus can emit after K-capture two gamma quanta with different energies, then two points corresponding to these gamma quanta are placed on the graph (for example, $^{75}_{34}Se$, $^{106}_{47}Ag$, etc.). The four main lines I, II, III, IV are described by the general expression following:

$$\log_{10}\tau = b - \frac{b}{a} E_\gamma$$

where $a_I = 1.64$ and $b_I = 7.3$,

$a_{II} = 1.81$ $b_{II} = 7.9$,

$a_{III} = 2.07$ $b_{III} = 8.5$,

$a_{IV} = 2.72$ $b_{IV} = 9.4$.

It should be noted that all straight lines are distinguished by selective properties relative to nuclear composition. Thus line I has no nuclei of elements with an odd number of neutrons N and with an odd number of protons Z, except $^{190}_{77}Ir$ and $^{206}_{83}Bi$. Line II also has no elements with odd Z and N, with the sole exception of $^{202}_{81}Tl$. Line IV, on the contrary, has nuclei with odd Z and N, but there are no nuclei with odd Z and even N, while the latter are present on the lines I and II; line III is the same, with the exception $^{135}_{57}La$. No one line contains nuclei with an even number of protons and an even number of neutrons, for which K-capture evidently is strongly forbidden (out of the total number 94 of nuclei for which K-capture is known, only four nuclei have even Z and N, namely $^{68}_{32}Ge$, $^{72}_{34}Se$, $^{100}_{46}Pb$, and $^{118}_{52}Te$).

In every case, line III divides the graph into two parts: a lower left part of the graph (that is, group A and lines I and II) contains mainly nuclei with an odd number of protons and an even number of neutrons and nuclei with an even number of protons and an odd number of neutrons, but barely contains nuclei with odd Z and N. The upper right part of the graph, however, that is, group B and the lines III and IV), generally contains nuclei with an even number of protons and an odd number of neutrons and nuclei with odd Z and N, but barely contains nuclei with odd Z and N.

The following table represents the composition of the nuclei in the lower left and, correspondingly, the upper right half of the graph.

Comp of Nuclei	Lower Left, Graph A, I, II	Upper Right, Graph B, III, IV
	No of Nuclei	
$Z = 2n$, $N = 2n + 1$	13	18
$Z = 2n + 1$, $N = 2n + 1$	4	11
$Z = 2n + 1$, $N = 2n$	14	2
$Z = 2n$, $N = 2n$	1	1

As is apparent from the table, nuclei with the composition Z = 2n and N = 2n + 1 are uniformly distributed over the entire graph and are present on every line and in every group approximately in identical amounts. It is impossible to establish any forbiddenness for them. For nuclei, however, with the composition Z = 2n + 1, N = 2n + 1 or with Z = 2n + 1, N = 2n, there does exist a definite forbiddenness: lines I, II and group A are forbidden for nuclei with the composition Z = 2n + 1, N = 2n + 1, but lines III, IV and group B are forbidden for nuclei with the composition Z = 2n + 1, N = 2n. All lines are forbidden for nuclei with the composition Z = 2n, N = 2n.

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